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ABSTRACT

This paper outlines a research program that focuses on organizational communication as a means for both normative and descriptive models of organization. The author proposes a methodology for the measurement of organizational structure that appears relevant for both laboratory and field study research. In addition, the basis for concepts of structure that promise to bridge the research gap between the development of organization theory and the pragmatics of organization design is presented. The use of the methodology for studying the concept of organization is demonstrated, and one particular concept of structure that evolves from the methodology is developed. Finally, some results from research that has been conducted using early forms of the approach are presented. These results indicate that certain patterns of communication, when distinguished by this methodology, are associated with particular a priori forms of organization, such as the authority structure and the task structure. (Author/JH)

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ANALYZING AN ORGANIZATION VIA ITS INTERNAL COMMUNICATION PATTERNS

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ABSTRACT

ANALYZING AN ORGANIZATION VIA ITS INTERNAL COMMUNICATION PATTERNS

An organization is essentially a set of well defined binary relations among the persons in that organization. The exercise of these relations is done through communication. Thus, without communication we have no organization. It would appear, then, that one effective way to determine the organization which exists in fact is to discover the communication patterns that take place within it. Furthermore, based on empirical evidence, the patterns of communication appear to be a function of the mode used. For example, the organization based on face-to-face relations is different from that based on the use of the telephone. This paper outlines a research program which focuses on organizational communication as a means for both normative and descriptive models of organization. Some results are presented which indicate that certain patterns of communication, when distinguished by the mode used, are associated with particular a priori forms of organization, such as the authority structure and the task structure.

ANALYSING AN ORGANIZATION VIA ITS INTERNAL COMMUNICATION

INTRODUCTION

The fields of organization theory and of organizational practice too frequently have been research independently of each other. While many reasons may exist to explain this unfortunate state of affairs, two principle ones can be cited.

1) Firstly, there has been a lack of common measures and the corresponding tools for measurement.

2) Secondly, meaningful and operational concepts of structure are not readily available which satisfy the research requirements of both the theorist and the practitioner.

The experimentalists, studying the concept of organization, have usually confined themselves to the study of structural properties over which laboratory control can be exercised. On the other hand, those studying operating organizations recognize the softness of field measurement techniques, and consequently have developed concepts of an overly general and crude nature. The problem is to define concepts and processes of measurement that are sufficiently refined to be useful for studying individual parameters of structure, as is often the case in laboratory research, and at the same time reflect practical structural relationships as may exist and be obtained in the field.

In this paper, we propose a methodology for the measurement of organizational structure that we believe is relevant for both laboratory and field study research. Further, we present the basis for concepts of structure which promise to bridge the research gap that exists between the development of organization theory and the pragmatics of organization design. The use of the methodology for studying the concept of organization is demonstrated and one particular concept of structure which evolves from the methodology is developed. Finally, we present some results from research that has been conducted using early forms of the approach.

FRAMEWORK FOR THE STUDY OF ORGANIZATIONAL COMMUNICATION

An organization is essentially a structured set of well defined binary relations among persons in that organization. The exercise of these relations can only be done through the process of communication. While most experts in the field have made statements to this effect, perhaps the one most relevant to the argument presented in this paper was made by Deutsch (1952, p. 367):

> "Communication and control are the decisive processes in organizations. Communication is what makes organizations cohere; control is what regulates their behavior. If we can map the pathways by which information is communicated between different parts of an organization and by which it is applied to the behavior of the organization in relation to the outside world, we will have gone far toward understanding that organization".

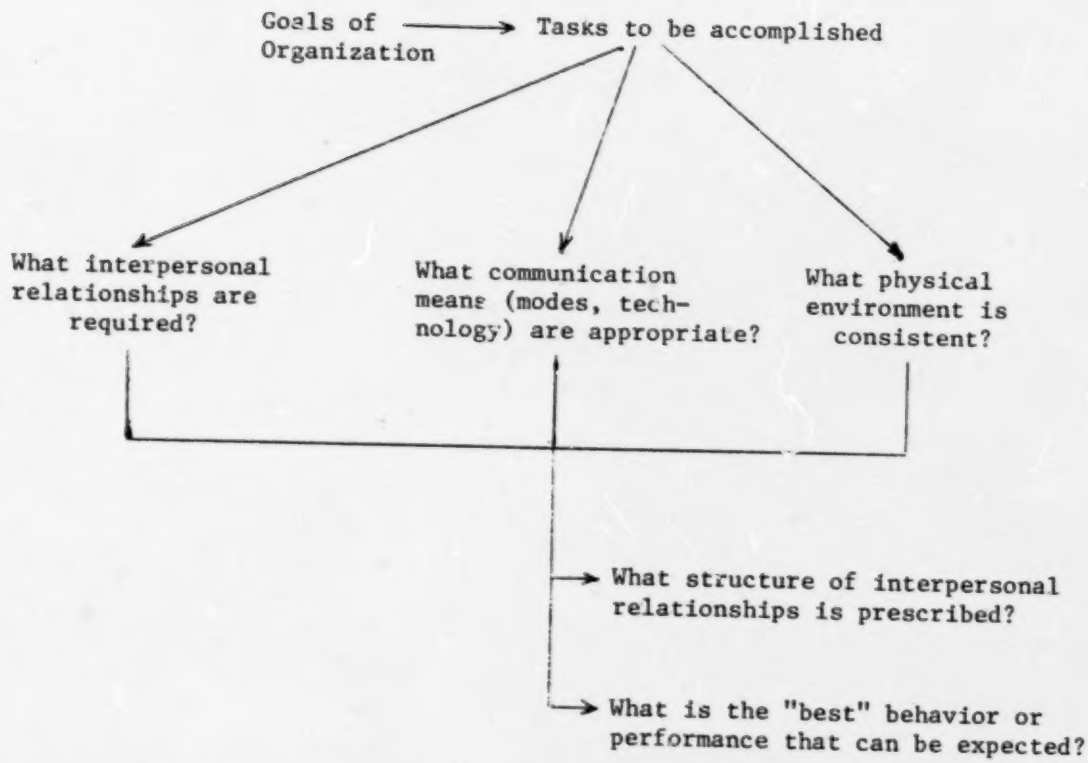
This has been recognized by the laboratory experimentalists (Bavales, 1950; Leavitt, 1951; and Mackenzie, 1967) and well as by those primarily interested in studying organizational practices (Eilon, 1968; and Pugh, et al, 1968).

In spite of this emphasis on the fundamental role played by communication, methods for using communication data and techniques for measurement still are not being used for both laboratory and field study research. The problems of applying laboratory results in the real world and of isolating interesting real world variables for controlled study in the laboratory remain. Because of our own research objectives and the way in which we have formulated our research program, we are being forced to face up to these problems squarely. To do this, we accept the premise that an organization is essentially a communication system and we proceed to develop concepts of organization and methodology for measurement which are meaningful and useful to both laboratory and field research.

Before going any further, let us put this work into the context of an overall research program. The long range goal of our research effort is to be able to prescribe how an organization should "organize" (that is, structure its interpersonal relationships), to identify what communications technology and equipment is appropriate in the fulfilment of this structure, and to prescribe the physical environment that is most compatible with the structure of people and the communications technology.

Recommendations derived from a normative model must recognize the interdependencies that exists between people, the means through with they relate to each other, and the environment in which they work. Furthermore, these recommendations must obviously be related to the purposes for which the organization is being created in the first place. Thus, a final normative model would be able to take the goals of an Organization (a particular organization), its existing personnel, and attempt to design a set of relationships, a physical environment and a communication network with its associated equipment, that would make the "best" use of the personnel in terms of the stated objectives, (Figure 1).

FIGURE 1: A Communications Approach to Organization


Goals of Organization
Tasks to be accomplished
What interpersonal relationships are required?
What communication means (modes, technology) are appropriate?
What physical environment is consistent?
What structure of interpersonal relationships is prescribed?
What is the "best" behavior or performance that can be expected?

Obviously a long range goal such as that stated above is not achieved merely by extensive contemplation. Many steps must be taken in order to acquire the understanding required. We must have more than descriptive knowledge of the organization and its inner workings, rather we must be able to explain the many complex cause and effect dependencies which add up to be an organization. We must be able to change, as designers, one or more of the variables which effect the structure of interpersonal relations and be reasonably confident that the consequences represent a movement toward a more desirable state.

This understanding can only be acquired through a balanced program of laboratory and field study research, and it is at this point that our research program is hindered by the realization that: (1) there is a lack of common measures and the corresponding tools for measurement and (2) meaningful and operational concepts of structure are not readily available which satisfy the research requirements.[1]

The following questions have been formulated as being fundamental to the achievement of our long range research objectives.

1. Why do people communicate within an organization?
2. When a choice of communication facilities exists so as to confront the individual with a range of characteristics and means, what factors affect one's particular choice?
3. What affect does the choice (usage) of a particular communication means have on the interpersonal processes in terms of structure of relationships and behavior within the structure?

To be meaningful and useful, concepts of organization, and measures and techniques for measurement should be pertinent to the answering of these questions through laboratory exploration and experimentation as well as field study.

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[1] It may be worth noting here that our research is being funded jointly by academic and industrial research sponsors in the belief that a joint research effort will force an improvement in this state of affairs.

THE MEASUREMENT OF INTERNAL COMMUNICATIONS

At this point a more sophisticated paper would undoubtedly allude to theory and hypotheses, but as far as we can tell there is little true theory in the field of organizational analysis, and none which treats the three questions posed above. Most research on organization has been of the exploratory type - it has involved the search of relevant theory rather than the rigorous testing of theory (March & Simon, 1958, is a classic example). But to be useful, the latter process must be undertaken. We do not want to be in the position of having developed abstract concepts which, though they may be rich in content, are incapable of being empirically justified or implemented. Pragmatics of data collection, then, is a foundation of our research efforts. Feasibility of measurement is to provide a constraint upon the nature of the theory which is to be developed.

The above position requires an interdependency between the development of concepts and theories, and the measures and techniques for measurement that will be used to test them. In this section we will discuss the measurement of the factors which, when put together, are expected to provide the basis for insights needed to establish working theory. To do so we look at the nature of the data content, how it is to be obtained and some uses to which it will be put. In the next section the emphasis will rest on the development of concepts to be used as a basis for understanding organizational phenomena.

1. Identification of Communication Patterns

One reflection of an Organization's structure is the pattern of communication (network usage) that takes place within it. To be able to discern these patterns it is necessary to know at least two things: (a) who communicates to whom - this produces, in effect, a directed graph establishing the existance of nodes and links, along with the direction of primary message flow; (b) volume, frequency of communication, total elapsed time, or what have you, for each of the links - this produces a measure of the quantity of network usage or traffic between each pair of nodes (usually persons). A third aspect of the network which should be measured relates to scale, that is, the number of participants (nodes) involved (usually simultaneously) in any given communication event. This is quite distinct from the number of nodes that a particular participant interacts with over a period of time. Such information is to be related to the constraints of the physical environment and of the communication facilities being used.

Probably the most effective way to obtain such data is via a simple check sheet diary of the type shown in Appendix 1. This is an adaptation of data collection methods used by the Quickborner Team for "rationalized" office landscaping (Lorenzen, 1969; Pile, 1969). The procedure has been field tested and has proven to be a desirable method for collecting communication pattern data (Conrath, 1971).

2. Characteristics of Communication Facilities

In addition to the structural properties of network usage cited above, it is essential to know something about the quality or performance characteristics of the links in the network. The simplest form that such data can take is the identification of the communication mode used for the interaction: paperflow, telephone, face-to-face, and certain subsets of these. This information allows us to differentiate among communication facilities so that we can understand the factors affecting choice of each type of facility and the effect that the usage of a particular facility has on interpersonal processes. Such data is also collected on the form given in Appendix A.

In the next two sections we will explore some of the apparent relationships between communication patterns evolving out of the use of a particular mode and the formal organizational structures. The study of communication mode characteristics is one area where a common ground needs to be established between the laboratory study of communication processes and field study of organizational behavior.

3. Characteristics of Physical Environment

To study the relationship between choice of communication mode, interpersonal processes, and the physical environment, the following three types of information are required: (a) the physical location of each participant (node), as measured by the distance and non-linearities (obstacles) between each pair of participants (see Barnlund & Harland, 1963); (b) the characteristics of each participant's work space whether enclosed, semi-private, office landscaped, etc.; and (c) a listing of primary and ancilliary communication facilities available to each individual. This data can be obtained most easily from a scale drawing of the office and plant layout, plus a check list questionnaire noting the characteristics of one's work environment to be completed by each subject. We shall comment in the next two sections also on the relationship between distance and mode usage.

4. The Formal Organization - the Authority Structure

A prime basis for much organizational communication is the formal authority structure. Since we are interested in the presumed structure, the various policy directives and organizational charts are an adequate source of this data. A prime purpose of obtaining such data is to compare this structure with those developed from other sources, and in particular empirically based structures defined by communication patterns.

5. The Working Organization - the Task Structure

Most Organizations that would wish to be "structured" have a set of well defined goals, and tasks or jobs that must be accomplished to meet these goals. These tasks, as formally defined, can be analysed in terms of the expectations implied or declared with respect to: (a) communication interdependencies i.e. the relations that must be established with others in order to accomplish the task, and (b) specific individual behavior (responsibilities) required of the incumbent. Both obviously imply certain communication behavior. An understanding of the relationships between communication and task would appear to be critical for any theorizing about organizational structure.

Two procedures may be followed to obtain this data:

(a) obtain existing job descriptions and analyse them extracting apparent prescribed relations and responsibilities. In our major field study, it was surprising how comprehensive most job descriptions were with respect to these factors.

(b) prepare special task description forms designed to obtain the communication requirements of a particular job in a format consistent with the other measurements to be taken in the organization. Such forms are in the process of being field tested and therefore have not been included in this paper.

6. Communication Content and Context

Information is required regarding the circumstances surrounding particular communication events and the properties of the actual transaction between the participants. Communication content, as we have called it, appears to be critical data for the understanding of the factors which influence one's choice of communication "means" as well as the subsequent effect on interpersonal behavior. Such data has been collected using the form shown in Appendix B. We attempted to find measures that would also be relevant for laboratory exploration and experimentation.

7. Characteristics of the Individual

Undoubtedly one's communication behavior is influenced by his personality and other characteristics unique to his person. But while we believe in its importance, its independent measurement is another matter. A great many models and mechanisms for personality measurement have been devised (Marlow & Gergen, 1969), but none of them can be said to be universally satisfactory (possess the ability to predict general characteristics of behavior under a wide variety of circumstances), and few are even satisfactory for specific behavioral predictions. Hence, we are not optimistic about uncovering a means for measuring the dimensions of personality affecting organizational communication, especially an instrument which is easy to administer and is acceptable to most organizations. Therefore, at the present, crude surrogates such as age, sex, education, time on the job and length of service with the Organization will be used. These are usually readily obtainable from personnel files. Eventually, it may prove to be the case that one's communication profile is a sufficient measure of "personality" for our purposes, and hence we would need no other exogenous data.

8. Performance

Before normative model building can be completed, communication behavior must be related to perceived success, or to performance of the individuals or of the collective organization. Unfortunately, most measures of performance in use are seen to be too sensitive and proprietory to obtain from a field study. Hence, one must make do with crude subjective ratings, or more objective data, such as profitability, obtained for large aggregations. Here again the success of our long range objectives may depend on measurements taken in a laboratory that can be generalized to an operating organization.

CONCEPTS AND A BASIS FOR THEORY

Up to this point we have not dealt specifically with the development of concepts for the better understanding of organizational phenomenon - concepts that will be useful to laboratory research and field research alike. In this section, we briefly review some of our approaches to the answering of the fundamental questions of organizational communication. The intent is not to concentrate on the search for answers, but rather to illustrate the development of concepts and methodologies that appear, at least so far, to be relevant and useful for a long term research program.

Of central importance to our work is the notion that communication facilities possess different characteristics, as perceived by the individual, and therefore the decision to acquire and use a particular facility from the set of those available becomes an important one. Further, facilities possessing such differentiated characteristics, when used, will produce distinguishable consequences for the Organization, in terms of the structure of interpersonal relationships and behavior or performance. It is important to establish this from the outset, for if these suppositions are not true, the only relevance communication technology has to an Organization is cost per bit of information, subject to environmental and technological constraints. On the other hand, if they are true then various aspects of structure can be fostered or retarded depending upon the availability of various technologies. Some would appear to be more suitable for certain organizational purposes, and therefore the range of choices that is made available becomes vitally important to the "designers" of the organization. Also, costs and benefits must be assessed within the context of the purpose and adequacy of the structure so produced.

Another supposition, which is really a corrollary of the above, is that an understanding of the characteristics possessed by differing communication facilities permits the researcher to conjecture about the choices regarding individual and collective acceptance and usage of both existing and potential communications technology. This understanding is likely to be enhanced by an interaction between laboratory and field exploration and experimentation.

In order to test the suppositions, three specific conjectures have been, and will continue to be, the subject of an empirical investigation.

(1) Among various modes of communication, the pattern of written communication will most closely parallel the formal authority structure.

(2) Among various modes of communication, the pattern of telephone communication will most closely parallel the task or work flow structure.

(3) Among various modes of communication, the face-to-face mode will be most influenced by physical proximity.

The first conjecture is based on the observation that most written communication is in that form because of its storage and/or multiple copy capability. The message is usually evidence of a decision, requiring either action or a recognition of the decision, or it presents information of fact or opinion which might affect a future decision. Such messages most commonly follow the chain of command, the recognized authority structure.

The second conjecture is related to the fact that the telephone network operates in real time. This allows for an immediate response to a quey, and errors of misinformation or a lack of information can be corrected before they become compounded. In addition, audio communication is relatively efficient from the message sender's standpoint since he can transmit more data per unit of time than he can using a written mode. These advantages also exist for face-to-face communication, and the major difference between the two is the perceived cost of channel (mode) use, usually based on the effort involved in both time and memory, relative to the perceived value. Hence, whenever the effort required to face-to-face communication is relatively large, another mode is used. This of course is the basis for office landscaping - the reduction of the effort required for face-to-face communication.

Task oriented communication makes up the vast majority of organizational communication, based on several crude content studies made to date. Since feedback is usually an important element for effective task performance, especially in aligning task interdependencies, the telephone is ideally suited to such interactions when the perceived cost of face-to-face interaction is too great. We should note here that perceived cost is also a function of management style.

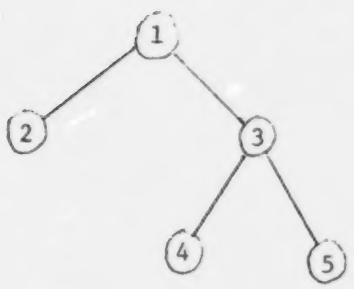
The third conjecture should be a rather obvious one. Not only is proximity the basis for office landscaping, but the research of Festinger, et al (1950) and Barnlund and Harland (1963) yielded similar results.

TESTING THE CONJECTURES

Measures

The testing of the first two conjectures is dependent upon: (a) the methods used to define and measure structure, and (b) the methods used to compare structures to test for equivalence. Since a discussion of these methods will help to establish useful concepts of organization, it is not a digression from our theme to discuss the quantification of structure.

The methods used to measure structure must be compatible with those used to identify communication patterns if we are to determine relative similarity. While some of this work has been explained in detail elsewhere (Conrath, 1971), we will briefly describe our current thinking. We feel that structure must account for each of the possible binodal relationships that can exist within an organization. Thus, the simplest mechanism for displaying and comparing structures is to represent them in a matrix format, the rows and columns denoting the individuals in the Organization. The entries in the cells, say an a_{ij}, indicates the relation between i and j. If we are describing a formal structure, for example the authority relations, then a_{ij} may indicate the existence of a directionrrelation between i and j (e.g. See Figure 2). If we wish to use a measure more complex than 0.1 then the entry could indicate the strength, location or importance of the authority relationship.



	1	2	3	4	5
1		1	1		
2	1				
3	1			1	1
4			1		
5			1		

Authority Structure

	1	2	3	4	5
1	-	7	3	0	2
2	4	-	1	0	1
3	4	5	-	7	11
4	1	0	4	-	6
5	0	2	15	3	-

Communication Volume

FIGURE 2: Matrix Representations

Likewise, if we use the matrix format to represent intra-organizational communication, the entries represent messages or traffic between i and j. For many purposes we will use the a_{ij} to indicate the volume of communication traffic between two nodes (Figure 2), for we wish to compare this pattern with other patterns of structure.

A wide variety of means exist to compare two matrices, but obviously the nature of the comparison ought to be explainable in terms of the purposes. Since our conjectures concern the proposition that one pattern, or matrix, is more similar to another than a third is to that other, we must be in a position to compare differences. Furthermore, the differences should reflect comparisons between binodal relations. Thus, the most straightforward way to test the conjectures is to compare a communication matrix, say A, to a formal structure matrix, say S, on a cell by cell basis. We label the new matrix of differences D^{as}, whose entries are d_{ij}^{as}. Similarly, we compare a second communication matrix, B, to S, leading to another matrix of differences, D^{bs}, with entries d_{ij}^{bs}. Now if we hypothesize that A is more like S than B is we should expect D^{as} to have essentially smaller entries than D^{bs}. Since basically we assume that each relation in an organization is equally important for the determination of structure (as assumption which could be easily relaxed - see Conrath, 1971, for another approach), this comparison can be done on a cell by cell basis, comparing d_{ij}^{as} with d_{ij}^{bs}, for every i, j combination. We then can state that A is more like S than B is if and only if d_{ij}^{as} is less than d_{ij}^{bs} more often than the reverse is true. Since these binodal communication relations are essentially independent one from the other, especially if we deal with only one half of a skew symmetric matrix, we can then test for significant differences between the number of most similar differences.

Two different measures are suggested. One is a simple 0, 1 measure, either an interaction has taken place between the two parties (1), or it has not (0). For the formal structure matrix 1 indicates the existence of a direct relationship (e.g. "i" was the boss or subordinate of "j"), 0 indicates its lack. Another set of comparisons can be made after the matrixes have been normalized across each row. Since the matrices will have been made skew symmetric, the normalization enabled us to seek a fit on a per individual basis that would not be perturbed by the absolute level of interaction. For an example of the above procedures, using a 0, 1 measure, see Figure 3.

FIGURE 3: Comparisons Among Matrices

(matrices skew symmetric, only consider entries above the diagonal)

	1	2	3	4
1	-	1	1	0
2	1	-	1	1
3	1	1	-	1
4	0	1	1	-

communication volume - A

	1	2	3	4
1	-	1	1	0
2	1	-	0	1
3	1	0	-	0
4	0	1	0	-

formal structure - S

	1	2	3	4
1	-	0	1	0
2	0	-	0	1
3	1	0	-	0
4	0	1	0	-

communication volume - B

	1	2	3	4
1	-	0	0	1
2	0	-	1	0
3	0	1	-	1
4	1	0	1	-

D^{as}

	1	2	3	4
1	-	1	0	0
2	1	-	0	0
3	0	0	-	0
4	0	0	0	-

D^{bs}

$d_{ij}^{as} < d_{ij}^{bs}$ 1 time

$d_{ij}^{bs} < d_{ij}^{as}$ 3 times

$\therefore$ B is more similar to S than A is.

Results

To provide an initial test of our conjectures we selected a sample of 30 individuals from one manufacturing plant. The subjects belonged to two departments, one engineering and the other manufacturing. They were selected for the initial test because both intra-departmental and cross departmental interaction were common. Each subject completed and the form shown in figure 1 for a five day period, recording all significant interpersonal interactions (those involving more than just personal greetings). As we were on location during part of the period data collection, we observed that the preponderance of interactions were recorded and the data so recorded reliable.

The results reflecting on the first conjecture are contained in Tables 1 and 2, for the 0, 1 and the normalized measures respectively. Interestingly, the results are not particularly sensitive to the measure used, though somewhat higher levels of significance are achieved via the 0, 1 measure. As conjected, the personnally addressed written communication pattern does prove to be the most similar to the authority structure, though not significantly moreso than the pattern of telephone usage. Both patterns are significantly closer to the authority structure than the one based on face-to-face communication.

Place Tables 1 and 2 about here.

Tables 3 and 4 display the comparisons between the task structure and the communication patterns, by mode, using the 0, 1 and the normalized measures respectively. As we had conjectured, the telephone usage pattern is the most similar to the task structure, significantly moreso than the pattern of written communication, and not quite significantly moreso than the face-to-face interaction pattern.

Place Tables 3 and 4 about here.

Our third conjecture obviously requires a different form of analysis. Each channel was measured on the basis of the distance between the two work stations. These distances were then put into classes, as indicated by Tables 5 and 6, each class containing approximately the same number of channels. Table 5 presents the percent of the channels available that were used over the five day period of data collection for each of the three basic modes of communication. Table 6 indicates the total traffic volume per channel, on the average, for each of the distances classes. In both cases the face-to-face communication

Place Tables 5 and 6 about here.

network is very highly correlated (negatively) with distance. The Spearman rank correlation coefficients are -.927 and -.864 for percent of channels used and traffic volume per channel respectively. Both coefficients are significant at the .01 level. The relationships between telephone traffic and physical distance between work stations are also strongly negatively correlated -.755 and -.558. The first coefficient is significantly different from zero at the .01 level, the second at the .05 level. The flow of personally addressed written communication was not significantly correlated with the distance between stations, the coefficients being -.082 and -.036 for the data on Tables 5 and 6 respectively. Thus, conjecture three also finds support on the basis of our sample data.

It is interesting that telephone traffic is associated inversely with the distance between persons. Several reasons may exist for this phonomenon. One lies in the method of data collection. We only asked for information about the parties to the communication, and not where they were located at the time. A number of the phone calls were made by persons away from their work stations to colleagues located in the same general work area. Hence, the actual distance traversed by the phone call is not recorded. This would have undoubtedly resulted in a lower negative correlation coefficient. Also, people were located near each other who had to work together, so naturally they had a greater reason for interacting among themselves, no matter what the mode, then they might have for interacting with others more distantly located. Presumably an interplant study would lead to considerably different results.

"RELATIONAL" CLUSTERING, A BASIS FOR STRUCTURE

Another phase of our research seeks to develop a purely empirical concept of organizational structure based on the use of a particular clustering technique, which we call "relational" clustering to distinguish it from the two common types of similarity clustering (usually referred to simply as clustering). Briefly, we wish to be able to group or cluster those persons who have a high degree of interation among themselves relative to the interaction they have with others. One common type of clustering is the minimum differences approach-group those things with relatively similar attributes (e.g. Johnson, 1967; Tryon & Bailey, 1970). The other type is the minimum weighted distance approach-group those things that are relatively near each other (e.g. Robinson, 1951; Miller, et al, 1969). Neither of these approaches is satisfactory for our purposes since we wish to relate items to each other on the relative strength of their pairwise relationships. Thus, we wish to cluster according to the relative density of

internal vs. external relations, but without the linearity constraint associated with the weighted distance algorithms.

Relational clustering, as we now know it, can be reduced to a simple expression:

$$\max_{A^c} \quad \frac{\sum a^c_{ij} \,/\, |A^c|}{\sum a^-_{ij} \,/\, |A^-|}$$

where $a^c_{ij} \in A^c$, the set of intra-cluster cell entries,

and $a^-_{ij} \in A^-$, the set of extra-cluster cell entries.

$|A^c| + |A^-| = |A|$, and

$$\sum a^c_{ij} + \sum a^-_{ij} = \sum a_{ij}; \quad a_{ij} \in A.$$

The only exceptions we can see to the use of maximizing the ratio of in-cluster density to out-of-cluster density occur when the distribution of cell entries is multi-modal. We have not yet decided how to deal with these exceptional cases, and as yet our data has not taken such a form.

We are developing a computer program to perform "relational" clustering, and in its current state it has proven to be quite efficient. The program searches for relatively large cell entries and attempts to form the largest acceptable clusters about these, relying on both average density of cluster criteria and the number of non-zero entries in proportion to the total number of entries.

The result of applying a "relational" clustering algorithm is to group together those individuals with relatively dense interaction patterns, some persons being in more than one cluster (they frequently are the links between two clusters) and others forming "single node" clusters as individuals. These first level clusters form the basis for the Organization, and they might be viewed as the funadmental elements in its structure (some may wish to view the individuals themselves as being more fundamental). Once such clusters have been formed, each then can be treated as an entity, with interaction strengths with other entities calculated as the average of the strengths of the members of the clusters. We then can apply the criteria for clustering anew, forming new clusters, which in reality are clusters of clusters. This process can be repeated up to the point where every node in the Organization is contained in a

single cluster (see Figure 4). This pyrimiding of the clusters forms the complete structure (a descriptive one) of the Organization. The hierarchy formed in this way defines the Organization as it exists in fact, as reflected through interpersonal communication behavior, rather than as it has been postulated based on some preconceived work flow or formal authority structure.

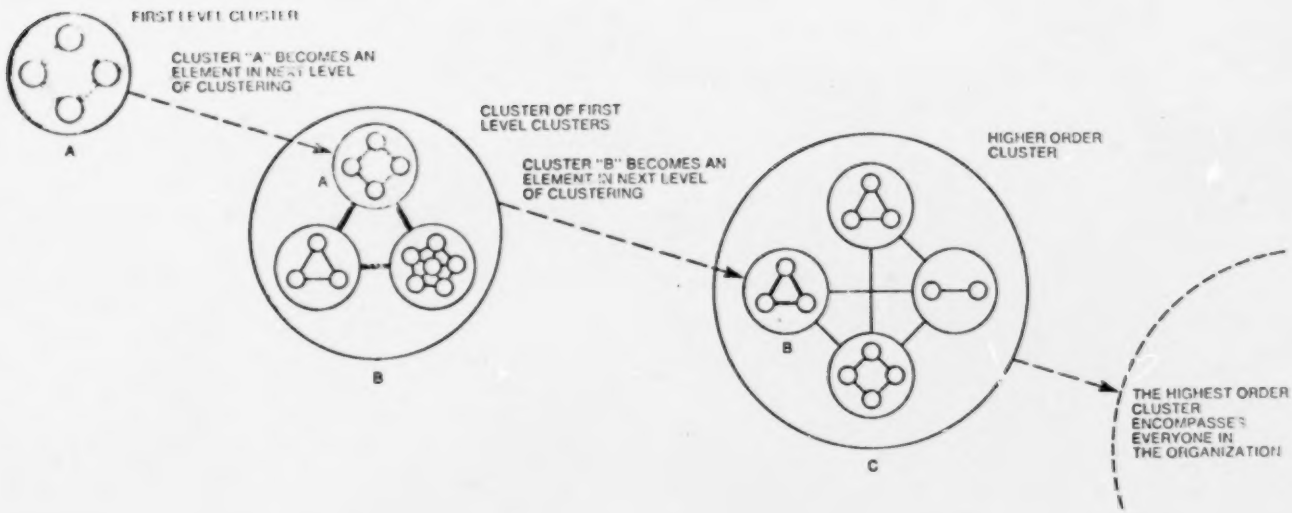

FIRST LEVEL CLUSTER
CLUSTER "A" BECOMES AN ELEMENT IN NEXT LEVEL OF CLUSTERING
A
CLUSTER OF FIRST LEVEL CLUSTERS
A
B
CLUSTER "B" BECOMES AN ELEMENT IN NEXT LEVEL OF CLUSTERING
HIGHER ORDER CLUSTER
B
C
THE HIGHEST ORDER CLUSTER ENCOMPASSES EVERYONE IN THE ORGANIZATION

FIGURE 4: An Organization as a Hierarchy of Clusters

Using "relational" clustering to empirically define an Organization serves more than just descriptive purposes. The process and its results also provide a basis for some normative observations. For example:

(1) Clustering tells us who relates to whom and with what grouping, independent of its size or position in the clustering hierarchy. Therefore, from a communication standpoint we can determine the relative importance of relationships to the fabric of the total organization. It would seem reasonable that these should receive special attention when contemplating organizational changes.

(2) Such a representative description of "reality" provides a desirable foundation in which to consider organizational purpose and performance both for the Organization as an entity and for particular sub-units. Such factors as personality characteristics are reflected in this descriptive model of the Organization (the clustering hierarchy), so that the "ideal" and the "reality" can be used to determine what can be done with what one has. This usable basis for suggested change is typically ignored by most organizational consultants.

(3) Clustering provides a concept of organization within which additional communication related data can be considered, especially with respect to its impact upon organizational structure. For example, we could have constructed the clusters on the basis of communication content rather than traffic volume between two points. Or the quality of the relations between nodes, as measured perhaps by some characteristic of the communication mode, could have provided our basis. Additionally, a thorough description of the concept of organization gives us a means with which we can extrapolate laboratory experimental results, especially those relating to new technology.

(4) The use of "relational" clustering to describe an Organization represents it as an integrated system - a system which can bring into focus the relationships between such things organizational structure and communication facilities, architecture and physical environment, personal communication idiosyncrasies, and so on. For this reason it should appeal to both the researcher and the practitioner.

CONCLUDING REMARKS

In this paper we have dealt with some of the concepts and methodologies which have been meaningful and relevant in our own research. Accepting the premise that an organization is essentially a communication system, we proceeded to develop concepts of structure and methodologies for measurement which appear to be interchangable between laboratory and field research. More specifically, the study of questions concerning patterns of communication and the various factors affecting communication behavior of individuals and groups, provides a robust empirical approach to the study of organizations. This approach appears to reflect, with sufficient sensitivity, all the major factors which affect the performance of an organization in pursuit of it's goals. Thus, we believe we are developing concepts of structure that promise to bridge the gap that exists between the development of organization theory and the pragmatics of prescriptive design. Some research results were presented to lend support to these claims.

As a final comment, not only do we believe that communication contains the essence of organizational structure, but that communication among those studying organizational phenomena is necessary if any advances of note are to take place. We hope this paper will provide the basis for establishing a few more channels of communication among students of organization than were open heretofore.

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Table 1

Similarity of Communication Patterns, by Mode, to Authority Structure, 0,1 Measurement

Mode Comparison		
D^{wa} vs. D^{pa}	D^{wa} vs. D^{fa}	D^{pa} vs. D^{fa}
$n(d_{ij}^{wa} < d_{ij}^{pa}) = 25$	$n(d_{ij}^{wa} < d_{ij}^{fa}) = 70$	$n(d_{ij}^{pa} < d_{ij}^{fa}) = 55$
$n(d_{ij}^{pa} < d_{ij}^{wa}) = 19$	$n(d_{ij}^{fa} < d_{ij}^{wa}) = 20$	$n(d_{ij}^{fa} < d_{ij}^{pa}) = 15$
level of significance*	level of significance*	level of significance*
.226	.001	.001

w - personally addressed written communication

p - telephone communication

f - face-to-face communication

a - authority structure

n - number of cell comparisons for which the inequality holds

* - using the normal approximation of the binomial distribution, p=.5

Table 2

Similarity of Communication Patterns, by Mode, to Authority Structure, Normalized Measurement

Mode Comparison		
D^{wa} vs. D^{pa}	D^{wa} vs. D^{fa}	D^{pa} vs. D^{fa}
$n(d_{ij}^{wa} < d_{ij}^{pa}) = 29$	$n(d_{ij}^{wa} < d_{ij}^{fa}) = 71$	$n(d_{ij}^{pa} < d_{ij}^{fa}) = 67$
$n(d_{ij}^{pa} < d_{ij}^{wa}) = 26$	$n(d_{ij}^{fa} < d_{ij}^{wa}) = 34$	$n(d_{ij}^{fa} < d_{ij}^{pa}) = 47$
level of significance* .394	level of significance* .001	level of significance* .038

w - personally addressed written communication

p - telephone communication

f - face-to-face communication

a - authority structure

n - number of cell comparisons for which the inequality holds

* - using the normal approximation of the binomial distribution, p=.5

Table 3

Similarity of Communication Patterns, by Mode, to Task Structure

0,1 Measurement

Mode Comparison		
D^{wt} vs. D^{pt}	D^{wt} vs. D^{ft}	D^{pt} vs. D^{ft}
$n(d_{ij}^{wt} < d_{ij}^{pt}) = 11$	$n(d_{ij}^{wt} < d_{ij}^{ft}) = 43$	$n(d_{ij}^{pt} < d_{ij}^{ft}) = 41$
$n(d_{ij}^{pt} < d_{ij}^{wt}) = 28$	$n(d_{ij}^{ft} < d_{ij}^{wt}) = 47$	$n(d_{ij}^{ft} < d_{ij}^{pt}) = 28$
level of significance* .006	level of significance* .376	level of significance* .075

w - personally addressed written communication

p - telephone communication

f - face-to-face communication

t - task structure

n - number of cell comparisons for which the inequality holds

* - using the normal approximation of the binomial distribution, p=.5

Table 4

Similarity of Communication Patterns, by Mode, to Task Structure

Normalized Measurement

Mode Comparison		
D^{wt} vs. D^{pt}	D^{wt} vs. D^{ft}	D^{pt} vs. D^{ft}
$n(d_{ij}^{wt} < d_{ij}^{pt}) = 20$	$n(d_{ij}^{wt} < d_{ij}^{ft}) = 51$	$n(d_{ij}^{pt} < d_{ij}^{ft}) = 63$
$n(d_{ij}^{pt} < d_{ij}^{wt}) = 37$	$n(d_{ij}^{ft} < d_{ij}^{wt}) = 56$	$n(d_{ij}^{ft} < d_{ij}^{pt}) = 49$
level of significance*	level of significance*	level of significance*
.017	.350	.110

w - personally addressed written communication

p - telephone communication

f - face-to-face communication

t - task structure

n - number of cell comparisons for which the inequality holds

* - using the normal approximation of the binomial distribution, p=.5

Table 5

Physical Distance and Communication Mode Use, Percent of Channels Used

Distance (in feet)	MODE: Face to Face Channels used	%	Telephone Channels used	%	Pers. Addressed Channels used	%	Number of channels available
0-99	26	65.0	9	22.5	3	07.5	40
100-199	19	43.2	14	31.8	2	04.5	44
200-299	14	35.9	5	12.8	2	05.1	39
300-399	11	26.8	4	09.8	3	07.3	41
400-499	12	26.1	9	19.5	1	02.2	46
500-599	8	22.9	4	11.4	2	05.7	35
600-699	3	07.7	1	02.6	0	00.0	39
700-799	6	13.3	6	13.3	3	06.7	45
800-899	1	04.4	2	08.7	2	08.7	23
900-999	1	02.1	0	00.0	1	02.1	48
1000-1300	4	11.7	3	08.8	2	05.9	34

Figure 5

PHYSICAL DISTANCE AND COMMUNICATION MODE USE, PERCENT OF CHANNELS USED

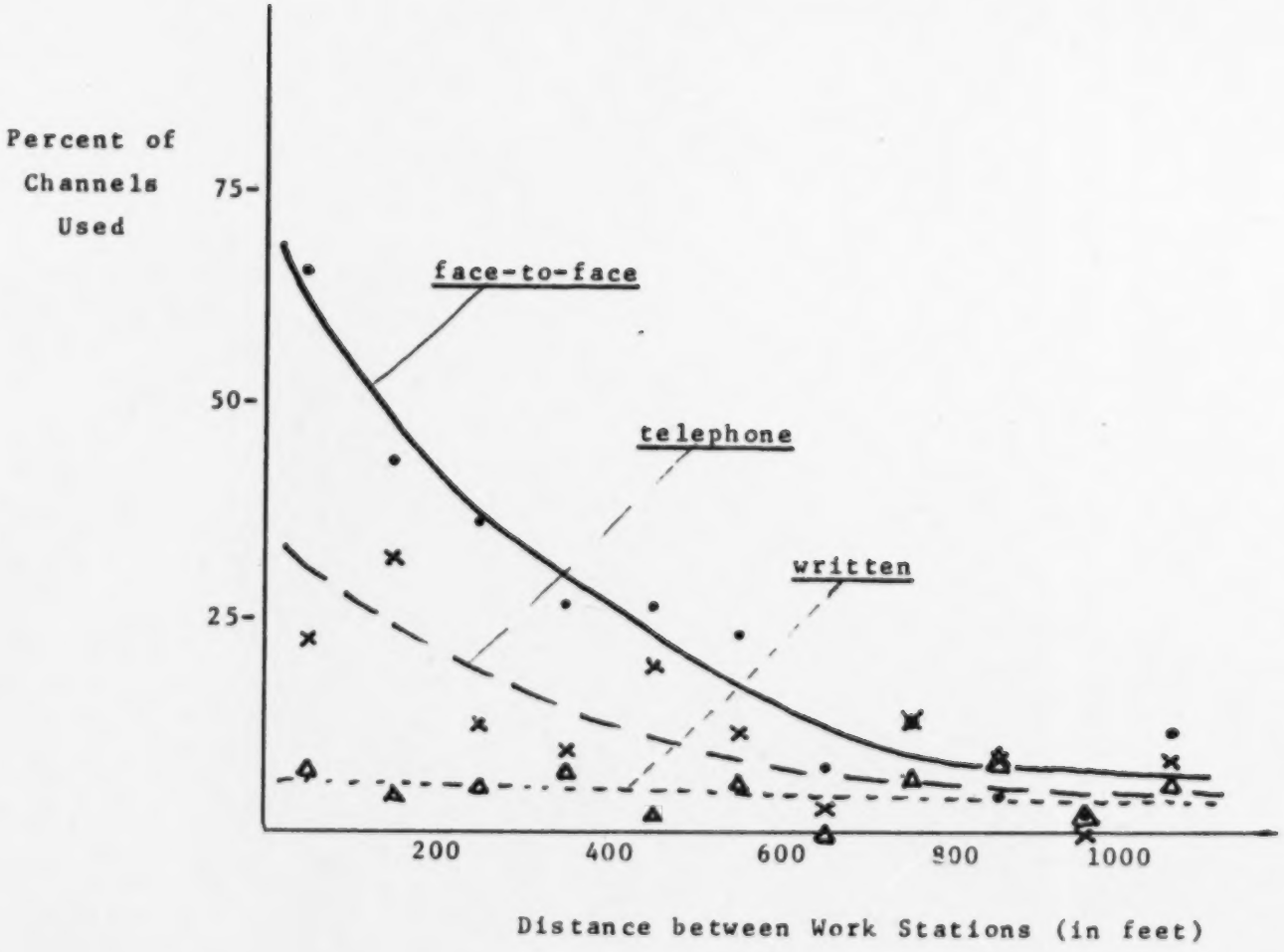


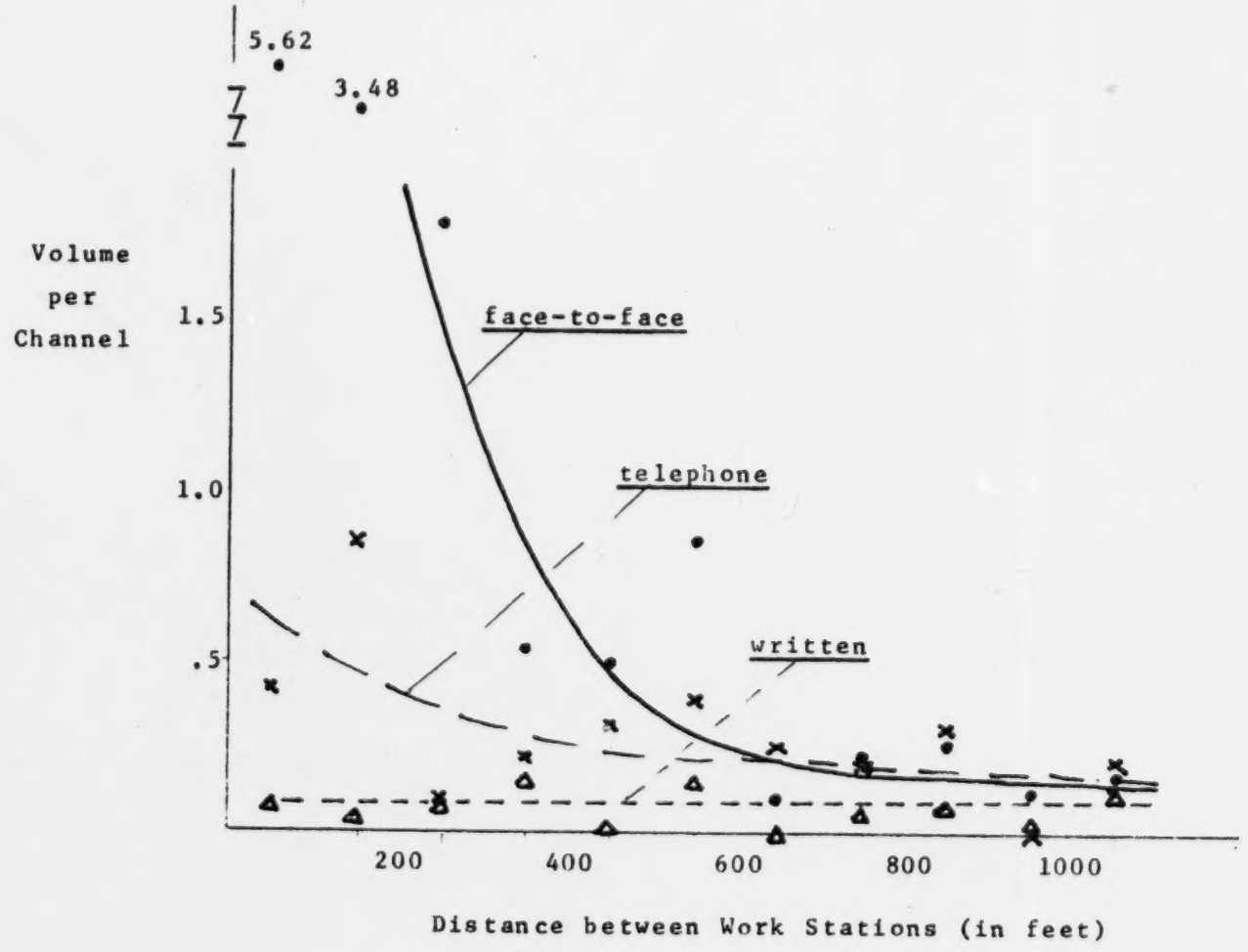
Table 6

Physical Distance and Communication Mode Use, Traffic Volume per Available Channels

	MODE						
	Face to Face		Telephone		Pers. Addressed		
Distance (in feet)	traffic volume	volume/ channel	traffic volume	volume/ channel	traffic volume	volume/ channel	channels available
0-99	225	5.62	17	.425	3	.075	40
100-199	153	3.48	38	.864	2	.045	44
200-299	70	1.79	4	.103	3	.077	39
300-399	22	..54	9	.219	6	.146	41
400-499	23	.50	15	.326	3	.022	46
500-599	30	.86	14	.400	5	.143	35
600-699	4	.10	1	.026	0	.000	39
700-799	10	.22	9	.200	3	.067	45
800-899	6	.26	7	.304	2	.087	23
900-999	6	.12	0	.000	1	.021	48
1000-1300	6	.18	7	.206	4	.118	34

Figure 6

PHYSICAL DISTANCE AND COMMUNICATION MODE USE, TRAFFIC VOLUME PER AVAILABLE CHANNELS



APPENDIX A

Communication Tally Sheet

							NAME					DATE			
IDENTIFY PERSON FROM WHOM YOU ARE RECEIVING COMMUNICATIONS	TELEPHONE CALLS			PERSONAL (FACE TO FACE) VISITORS							PAPER				
				1 VISITOR			2 OR 3 VISITORS			4 OR MORE VISITORS		ALL OTHER MATTER			
	SHORTER THAN 3 MINUTES	3 TO 15 MINUTES	LONGER THAN 15 MINUTES	SHORTER THAN 3 MINUTES	3 TO 15 MINUTES	LONGER THAN 15 MINUTES	SHORTER THAN 3 MINUTES	3 TO 15 MINUTES	LONGER THAN 15 MINUTES		PERSONALLY ADDRESSED	SHORTER THAN 3 MINUTES	3 TO 15 MINUTES	LONGER THAN 15 MINUTES
DISTRIBUTION SALES DIV.														
SWITCHING DIVISION														
TRANSMISSION DIVISION														
WIRE & CABLE DIVISION														
R & D DIVISION														
CORPORATE (ALL OTHERS N.E.)														
BELL CANADA														
OTHER CUSTOMERS SUPPLIERS														
OTHERS (NOT N.E.)														

Instructions for the Communication Tally Sheet

WHY HAVE A TALLY? MR. G. JOHNSON OF THE SYSTEM ENGINEERING DEPARTMENT IN THE R & D LABS, OTTAWA AND PROFESSOR D. CONRATH OF THE UNIVERSITY OF WATERLOO ARE CONDUCTING A SERIES OF INTRA-ORGANIZATIONAL COMMUNICATION STUDIES. THESE ARE DESIGNED TO ENABLE US TO BETTER UNDERSTAND ORGANIZATIONAL COMMUNICATION PROCESSES, AND AS A CONSEQUENCE, TO AID US IN THE DEVELOPMENT OF APPROPRIATE APPARATUS FOR THIS LARGE SEGMENT OF OUR MARKET.

WHEN WILL THE TALLYING BE DONE? THE TALLY WILL BEGIN WITH WORK ON MONDAY, NOVEMBER 30 AND CLOSE WITH THE END OF THE WORK DAY ON FRIDAY, DECEMBER 4. ON THE MORING OF NOVEMBER 30, YOU RECEIVED FROM YOUR DEPARTMENTAL REPRESENTATIVE YOUR FIRST TALLY SHEET. AT THE BEGINNING OF EACH DAY DURING THE TALLY PERIOD, THE PREVIOUS DAY'S TALLY SHEET WILL BE COLLECTED AND NEW BLANKS WILL BE DISTRIBUTED. PLEASE ENSURE THAT YOUR NAME AND THE DATE ARE ENTERED ON YOUR NEW BLANK ONE.

WHAT IS TALLIED? THE FOLLOWING CONTACTS (COMMUNICATIONS) ARE TO BE TALLIED:

1) ALL TELEPHONE CALLS DIRECTED TO YOU
2) ALL PERSONAL (FACE-TO-FACE) VISITORS RECEIVED (FORMALLY OR INFORMALLY).
3) ALL PAPER MATTER RECEIVED - LETTERS, MEMOS, REQUISITIONS, REPORTS, PERIODICALS, INSTRUCTIONS, IBM CARDS, ETC. EACH BATCH FROM ONE SOURCE IS CONSIDERED AS ONE CONTACT REGARDLESS OF THE NUMBER OF PAGES.

PERSONAL VISITS RECEIVED (ANY FACE-TO-FACE CONVERSATION IN YOUR WORK SPACE) AND FACE-TO-FACE CONFERENCE ARE DIVIDED INTO THREE CATEGORIES: VISITS BY ONE PERSON, BY TWO OR THREE, OR BY FOUR OR MORE.

PAPER COMMUNICATIONS ARE DIVIDED INTO TWO CATEGORIES: PERSONALLY ADDRESSED, HEREIN DEFINED AS THOSE WRITTEN COMMUNICATIONS INTENDED FOR YOU AND ONLY YOU; AND ALL OTHER MATTER. ONLY PERSONAL LETTERS, MEMOS, AND NOTES WILL BE IN THE FIRST CATEGORY.

ALL COMMUNICATIONS, EXCEPT THOSE CATEGORIES INVOLVING 4 OR MORE VISITORS AND PERSONALLY ADDRESSED PAPER MATTER, ARE FURTHER SUB-DIVIDED ACCORDING TO TIME CLASSIFICATIONS; LESS THAN 3 MINUTES, FROM 3 TO 15 MINUTES, AND LONGER THAN 15 MINUTES. THESE TIME CLASSIFICATIONS REFER TO THE PERIOD OF TIME SPENT ENGAGED IN THE COMMUNICATION EVENT. IN THE CASE OF COMMUNICATIONS INVOLVING PAPER RECEIVED, RECORD THE AMOUNT OF TIME SPENT READING IT ONLY AND NOT THE TOTAL TIME SPENT ACTING UPON IT.

HOW IS THE TALLYING DONE?

AFTER YOU HAVE RECEIVED A PHONE CALL, A PERSONAL VISIT, OR PAPER MATTER FROM SOME ONE PERSON (THE SENDER OF A WRITTEN MESSAGE IS THE ONE WHO SIGNS IT. IF UNSIGNED, THEN THE ONE WHO IS LISTED AS IT BEING "FROM"), FIRST RECORD THE IDENTIFICATION OF THAT PERSON IN THE LEFT HAND COLUMN. IF THE PERSON BELONGS TO THE APPARATUS DIVISION (NO MATTER WHAT LOCATION) THEN RECORD THAT PERSON BY NAME. IF THE PERSON DOES NOT BELONG TO THIS GROUP, THE RECORDING OF THE COMMUNICATION SHOULD BE DONE IN THE ROW OPPOSITE THE THE APPROPRIATE GROUPING LISTED AT THE BOTTOM OF THE TALLY FORM. IF A PERSON HAS ALREADY CONTACTED YOU ON A GIVEN DAY, THEN YOU SHOULD HAVE THEM LISTED IN THE LEFT HAND COLUMN AND YOU NEED NOT DO SO AGAIN.

PLEASE MAKE SURE YOU HAVE IDENTIFIED THE PERSON UNAMBIGUOUSLY BY NAME SO THAT HE OR SHE CANNOT BE CONFUSED WITH ANY OTHER PERSON. (PLEASE BE SURE TO STATE YOUR NAME TO MAKE IT EASIER AND FASTER FOR THE RECEIVING PARTY TO RECORD THE COMMUNICATION). RECORD BY PERSON (NAME) IF HE IS A MEMBER OF THE APPARATUS DIVISION (ANY LOCATION) AND BY ORGANIZATIONAL GROUPING (LISTED AT THE BOTTOM OF THE TALLY SHEET) IF HE IS NOT.

TO THE RIGHT OF THE PERSON'S NAME COMMUNICATING WITH YOU PLACE A MARK, / IN THE APPROPRIATE COLUMN - DENOTING PHONE CALLS, 1 PERSONAL VISITOR, 2 OR 3 PERSONAL VISITORS, 4 OR MORE VISITORS, PERSONALLY ADDRESSED PAPER, OR ALL OTHER MATTER. ALSO BEING AWARE OF THE LENTH OF TIME INVOLVED IN THE CONTACT A MARK OUGHT TO BE MADE IN THE APPROPRIATE COLUMN FOR EACH DISTINCT COMMUNICATION THAT YOU RECEIVE.

NON-WORKSPACE BUSINESS CONTACTS (THOSE WHERE BUSINESS IS DISCUSSED AT LUNCH, IN THE ELEVATOR, IN THE HALL, IN WASHROOM, ETC.) DURING THE WORK DAY SHOULD BE RECORDED BY ALL PARTIES, AS IF THEY RECEIVED A VISITOR (OR VISITORS), IN THE APPROPRIATE VISITOR COLUMN. MARK WITH AN X, RATHER THAN A /.

WHEN A CONFERENCE OR COMMITTEE MEETING IS CALLED, ONLY THE PERSON CALLING IT RECORDS THE NAMES OF THE PERSONS, AND THE RELEVENT MARKS IN THE APPROPRIATE PERSONAL VISITORS COLUMN. NOTE, EACH PERSON ATTENDING THE MEETING SHOULD HAVE A MARK BESIDE HIS NAME, EVEN THOUGH IT MIGHT APPEAR IN THE "4 OR MORE" COLUMN.

IF IT IS NOT CLEAR AS TO WHO IS VISITING WHOM, AMONG TWO OR MORE PERSONS WHO ARE TALLYING, THE PERSON WHO IS NEAREST HIS WORK SPACE SHOULD RECORD THE CONTACT.

WHEN YOU ARE AN INTERMEDIARY IN A COMMUNICATION, YOU SHOULD NOT RECORD IT. EXAMPLES WOULD BE SOMEONE TRANSFERRING A CALL TO THE INTENDED PARTY, OR RECEIVING MAIL JUST TO DELIVER IT TO SOMEONE ELSE, OR DIRECTING A PERSON TO SOMEONE ELSE'S OFFICE.

IT IS NOT REQUIRED THAT A SECRETARY AND HER MANAGER RECORD COMMUNICATION WITH EACH OTHER. A SECRETARY SHOULD RECORD ONLY THOSE COMMUNICATIONS THAT ARE INTENDED FOR HER, AND NOT FOR HER MANAGER (UNLESS SHE ACTUALLY HANDLES THE COMMUNICATION - E.G. ANSWERING A QUESTING EVEN THOUGH THE CALL MIGHT HAVE BEEN INTENDED FOR HER MANAGER). SHE SHOULD NOT RECORD THOSE COMMUNICATIONS COMING DIRECTLY FROM HER MANAGER LIKEWISE. THE MANAGER SHOULD TALLY THOSE COMMUNICATIONS DIRECTED TO HIM, BUT EXCLUDE THOSE FROM HIS SECRETARY.

IF YOU ARE A SHOP SECTION CHIEF YOU SHOULD GROUP YOUR SUBORDINATES AS ONE ENTRY ON YOUR TALLY SHEET.

IF THERE ARE NOT ENOUGH ROWS ON YOUR TALLY SHEET FOR A GIVEN DAY, PLEASE GET ANOTHER TALLY SHEET FROM YOUR DEPARTMENTAL REPRESENTATIVE.

ABSENCE IF YOU ARE ABSENT FROM THE BUILDING, EITHER BECAUSE OF A BUSINESS TRIP, ILLNESS, OR HOLIDAYS, THE FRACTION OF THE DAY THAT YOU ARE GONE SHOULD BE RECORDED BELOW.

DATE					
BUSINESS TRIP					
ILLNESS, HOLIDAY					

REMAINING QUESTIONS: IF YOU STILL HAVE ANY QUESTIONS, PLEASE CONTACT YOUR DEPARTMENTAL REPRESENTATIVE WHO DISTRIBUTES AND COLLECTS YOUR TALLY SHEETS.

WE THANK YOU WE ARE DEPENDENT UPON YOU FOR THE SUCCESS OF THE STUDY. PLEASE HELP US BY TALLYING AS ACCURATELY AS POSSIBLE.

APPENDIX B

Name _____ Date _____ Sheet # _____

COMMUNICATION CONTENT

		1	2	3	4	5	6	7	8	9	10	11	12
OTHER PARTIES	L - N - B - O - all others (names or initials / number)												
MODE	face-to-face												
	messenger												
	handset												
	hands-free device												
	paper: general												
	personally addressed paper												
LOCATION	own work space												
	other party work space												
	neutral space												
TIME ELAPSED	less than 3 mins.												
	3 to 15 mins.												
	15 mins. to 1 hour												
	over 1 hour												
	approx. # of hours												
TOPICS	manufacturing												
	engineering												
	marketing												
	administration												
	personnel												
	training												
	finance/accounting												
	public relations												
	research/development												
	personal business												
INTERACTION PROCESSES	asking, requesting												
	answering, responding												
	discussing/problem solving												
	decision making												
	persuading, convincing												
	bargaining, negotiating												
	informing (what)												
	instructing (how)												
	advising, suggesting												
	directing, ordering												
	reporting (preplanned)												
COMMUNICATION AIDS (✓-used, 0-useful)	hand-drawn images												
	pre-drawn images												
	printed matter												
	still pictures												
	moving pictures												
	hands free												
	audio aids (tapes, etc.)												
	physical objects												
	own filing system												
	central filing system												
	processing aids												
USE OF INFORMATION	don't intend to												
	think about it												
	act on it												
	file it, physically												
	file it, mentally												
	ask someone about it (who?)												
	expand it (who?)												
	summarize it (who?)												
	repeat it												
ENVIRON. FACTORS	lack of privacy												
	visual distractions												
	audible distractions												
	telephone interruption												
	face-to-face interruption												
	multi-conversations												
PREVIOUS FAILURES	how many times?												
	couldn't locate him												
	he was occupied (busy)												
	changed mode												
ATTITUDE	1-satisfying/dissatisfying-5												
	1-unimportant/important-5												
	1-personal/impersonal-5												
	1-non-urgent/urgent-5												
	1-productive/non-productive-5												
	1-boring/stimulating-5												